

## CONFIDENCE\_LEVEL\_NOTE (Richard Starr, 2013)

### Confidence Level Overview

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The XRS EDR data are the least processed data set released for the XRS. Data presented here are an accurate representation of the XRS data as received from the spacecraft, with minimal timing and no spatial processing.

### Review

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The XRS EDR was reviewed internally by the XRS team prior to release to the PDS. PDS also performed an external review of the XRS EDR.

### Data Coverage and Quality

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Data reported are the minimally processed data received from the spacecraft during the seventeen mission phases: Launch, Earth Cruise, Earth Flyby, Venus 1 Cruise, Venus 1 Flyby, Venus 2 Cruise, Venus 2 Flyby, Mercury 1 Cruise, Mercury 1 flyby, Mercury 2 Cruise, Mercury 2 flyby Mercury 3 Cruise, Mercury 3 flyby, Mercury 4 Cruise, Mercury Orbit, Mercury Orbit Year 2, and Mercury Orbit Year 3. These mission phases are defined as:

Phase Name	Start time Date (DOY)	End time Date (DOY)
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Launch	3 Aug 2004 (216)	12 Sep 2004 (256)
Earth Cruise	13 Sep 2004 (257)	18 Jul 2005 (199)
Earth Flyby	19 Jul 2005 (200)	16 Aug 2005 (228)
Venus 1 Cruise	17 Aug 2005 (229)	9 Oct 2006 (282)
Venus 1 Flyby	10 Oct 2006 (283)	7 Nov 2006 (311)
Venus 2 Cruise	8 Nov 2006 (312)	22 May 2007 (142)
Venus 2 Flyby	23 May 2007 (143)	20 Jun 2007 (171)
Mercury 1 Cruise	21 Jun 2007 (172)	30 Dec 2007 (364)
Mercury 1 Flyby	31 Dec 2007 (365)	28 Jan 2007 (28)
Mercury 2 Cruise	29 Jan 2008 (29)	21 Sep 2008 (265)
Mercury 2 Flyby	22 Sep 2008 (266)	20 Oct 2008 (294)
Mercury 3 Cruise	21 Oct 2008 (295)	15 Sep 2009 (258)
Mercury 3 Flyby	16 Sep 2009 (259)	14 Oct 2009 (287)
Mercury 4 Cruise	15 Oct 2009 (288)	3 Mar 2011 (62)
Mercury Orbit	4 Mar 2011 (63)	17 Mar 2012 (77)
Mercury Orbit Year 2	18 Mar 2012 (78)	17 Mar 2013 (76)
Mercury Orbit Year 3	18 Mar 2013 (77)	17 Mar 2014 (76)

No XRS data were collected during Earth Flyby or Venus 1 Flyby phases. The

XRS was on for some of each of the other fifteen mission phases. During these planned operational periods, the XRS functioned nominally and the data quality was good. Specific XRS operational periods were:

Phase Name	Start time Date (DOY)	End time Date (DOY)
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Launch	30 Aug 2004 (243)	30 Aug 2004 (243)
Earth Cruise	07 Feb 2005 (038)	11 Feb 2005 (042)
	14 Apr 2005 (104)	14 Apr 2005 (104)
	09 July 2005 (190)	13 July 2005 (194)
Earth Flyby	No Data	
Venus 1 Cruise	16 Jan 2006 (016)	13 Feb 2006 (044)
	06 Sep 2006 (249)	10 Sep 2006 (253)
Venus 1 Flyby	No Data	
Venus 2 Cruise	27 Jan 2007 (027)	31 Jan 2007 (031)
Venus 2 Flyby	26 May 2007 (146)	20 Jun 2007 (171)
Mercury 1 Cruise	21 Jun 2007 (172)	08 Aug 2007 (220)
	17 Aug 2007 (229)	25 Aug 2007 (237)
	20 Dec 2007 (355)	30 Dec 2007 (364)
Mercury 1 Flyby	31 Dec 2007 (365)	21 Jan 2007 (21)
Mercury 2 Cruise	28 Mar 2008 (88)	21 Sep 2008 (265)
Mercury 2 Flyby	22 Sep 2008 (266)	20 Oct 2008 (294)
Mercury 3 Cruise	21 Oct 2008 (295)	19 Nov 2008 (324)
	15 Jan 2009 (15)	17 May 2009 (137)
	28 Aug 2009 (240)	01 Sep 2009 (244)
	04 Sep 2009 (247)	15 Sep 2009 (258)
Mercury 3 Flyby	16 Sep 2009 (259)	29 Sep 2009 (272)
Mercury 4 Cruise	15 Oct 2009 (288)	3 Mar 2011 (62)
Mercury Orbit	4 Mar 2011 (63)	17 Mar 2012 (77)
Mercury Orbit Year 2	23 Mar 2012 (83)	17 Mar 2013 (76)
Mercury Orbit Year 3	18 Mar 2013 (77)	17 Sep 2014 (260)

The XRS gas proportional counters were intentionally powered down on 7 June 2007, following the Venus 2 flyby. The solar monitor remained on throughout the Venus 2 Flyby phase.

During Mercury 1 Cruise the gas proportional counters were on from August 4-8, August 17-24, and December 20-30. The solar monitor was on for all of the indicated time periods.

The XRS gas proportional counters were intentionally powered down on 15 January 2008, following the Mercury 1 flyby. The XRS was powered down on 21 January 2008.

The XRS was powered up on 28 March 2008 and remained on throughout the

remainder of the Mercury 2 Cruise phase and the entire Mercury 2 Flyby phase. During the Mercury 2 Cruise phase the aluminum filtered gas proportional counter safed itself for 1 hour on two separate occasions, 28 August (241) and 7 September (251). These two safing events were caused by excessive count rates in the anti-coincidence wires of the counter. The gas proportional counters were intentionally powered down on 7 October, following the Mercury 2 flyby. The solar monitor remained on throughout the Mercury 2 Flyby phase.

The solar monitor remained on during Mercury 3 Cruise until 19 November 2008. The entire XRS was powered up again on 15 January 2009. The gas proportional counters were intentionally turned off on 22 January 2009 and then powered up again on 7 May 2009. The entire instrument was powered off on 17 May 2009.

The XRS was powered up on 28 August 2009 and was powered down on 1 September 2009 due to spacecraft safing. After spacecraft recovery, XRS was powered up on 4 September 2009 and remained on until 29 September 2009. Power down was again due to spacecraft safing.

During the Mercury 4 Cruise phase of the mission, the GPCs were powered on primarily for Cas-A observations, 22 January 2010 to 29 January 2010, 30 March 2010 to 5 April 2010, 13 July 2010 to 19 July 2010, and 22 October 2010 to 29 October 2010. Other time periods with GPC HV on were 23 July 2010 to 29 August 2010, and 6 December 2010 to 23 December 2010. The solar monitor was on throughout this mission phase.

Once in orbit, the XRS detectors were on continuously except where spacecraft operations (eclipses) and instrument health and safety (temperature and count rate) required some or all of the detectors to be turned off.

The XRS GPCs experienced a number of safing events during early orbit. During these safing events one or more of the GPCs safed due to high count rate and remained off for 1 hour until autonomous recovery. On 25 April the safing limit for the GPCs was increased from  $5000 \text{ s}^{-1}$  to  $10000 \text{ s}^{-1}$  and the autonomous time to recover was reduced from 60 minutes to 5 minutes.

MESSENGER experiences a hot planet/long eclipse season every ~88 days. During these times spacecraft periapse is over a sunlit portion of the planet and eclipses exceed 15 minutes. Initially, long eclipses required instrument power off for ~2 hours for each orbit due to spacecraft power limitations. Beginning in August 2012, this restriction was lifted and the GPCs remained on during eclipse, but the solar monitor is still powered off when thermal modeling shows that the temperature is likely to exceed the red limit (30 degrees C). In addition, when the solar monitor temperature exceeds ~19 degrees C, spectra are dominated by electronic noise and are generally of little scientific value. Hot planet/long eclipse seasons are typically about 2 weeks in duration. The ten seasons experienced

so far began on 25 May 2011, 21 August 2011, 15 November 2011, 11 February 2012, 8 May 2012, 13 August 2012, 14 November 2012, 23 February 2013, 20 May 2013, 15 August 2013.

On 5 March 2012 a large solar particle event produced severe radiation damage in the XRS solar monitor. Above  $-10\text{ }^{\circ}\text{C}$  leakage current in the solar monitor was so high that spectra were of no scientific value. A two day anneal at  $100\text{ }^{\circ}\text{C}$ , beginning on 20 March 2012, improved the situation significantly so that good solar monitor spectra could be collected up to  $\sim+5\text{ }^{\circ}\text{C}$ . A second two day anneal, beginning on 3 April 2012, produced only marginal improvement. No other anneals are planned. After 22 March 2012, only solar spectra collected when the detector temperature is  $\sim 2\text{ }^{\circ}\text{C}$  or less should be used for science analysis.

On 28 February 2013, 11 May 2013, 4 June 2013, and 29 August 2013 the solar monitor temperature exceeded its red limit and the detector safed itself. In each case the solar monitor remained off for several days. Also, on 26 August 2013, the XRS was safed by a spacecraft autonomy rule. XRS remained off for about 1 day.

On 20 August 2013 a large solar particle event caused the GPCs to safe and remain off for about 3 days. This solar particle event also affected operation of the solar monitor. The solar monitor noise level increased and the detector no longer provided solar spectra above  $\sim 0\text{ }^{\circ}\text{C}$ . A three day anneal was performed 9-12 September 2013. This anneal increased the useful upper level operating temperature of the solar monitor back to where it had been prior to the 20 August 2013 solar event.

#### Limitations

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This data set is minimally processed data. The data are received from the spacecraft telemetry and ingested into the MESSENGER Science Operations Center (SOC). No data gaps have been identified for any of the XRS operational periods.